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### ANTHRAX IN CATTLE, HORSES, AND MEN.<sup>a</sup>

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[Revised in 1904 by Drs. Salmon and Mohler.]

#### ANTHRAX IN CATTLE.

Anthrax, or charbon, may be defined as an infectious disease which is caused by specific bacteria, known as anthrax bacilli, and which is more or less restricted by conditions of soil and moisture to definite geographical localities. While it is chiefly limited to cattle and sheep, it may be transmitted to goats, horses, cats, and certain kinds of game. Smaller animals, such as mice, rabbits, and guinea pigs, speedily succumb to inoculation. Dogs and hogs are slightly susceptible, while fowls are practically immune. The variety of domesticated animals which it may attack renders it one of the most dreaded scourges of animal life. It may even attack man. Of this more will be stated farther on.

*Cause.*—The cause of anthrax is a microscopic organism known as the anthrax bacillus. In form it is cylindrical, or rod-like, measuring  $\frac{1}{1000}$  to  $\frac{1}{500}$  inch in length and  $\frac{1}{1000}$  inch in diameter. Like all bacteria, these rod-like bodies have the power of indefinite multiplication, and in the body of infected animals they produce death by rapidly increasing in numbers and producing substances which poison the body. In the blood they multiply in number by becoming elongated and then dividing into two, each new organism continuing the same process indefinitely. Outside of the body, however, they multiply in a different way when under conditions unfavorable to growth. Oval bodies, which are called spores, appear within the rods, and remain alive and capable of germination after years of drying. They also resist heat to a remarkable degree, so that boiling water is necessary to destroy them. The bacilli themselves, on the other hand, show only very little resistance to heat and drying. It has long been known

<sup>a</sup> Reprint from Special Report on the Diseases of Cattle, and Special Report on Diseases of the Horse. 1904.

that the anthrax virus thrives best under certain conditions of the soil and on territories subject to floods and inundations. The particular kinds of soil upon which the disease is observed are black, loose, warm, humous soils, also those containing lime, marl, and clay, finally peaty, swampy soils resting upon strata which hold the water, or, in other words, are impervious. Hence, fields containing stagnant pools may be the source of infection. The infection may be limited to certain farms, or even to restricted areas on such farms. Even in the Alps, over 3,000 feet above sea level, where such conditions prevail in secluded valleys, anthrax persists among herds.

Aside from these limitations to specific conditions of the soil anthrax is a disease of world-wide distribution. It exists in most countries of Europe, in Asia, Africa, Australia, and in our own country in the lower Mississippi Valley, the Gulf States, and in some of the Eastern and Western States. It seems to be gradually spreading in this country and occurs in new districts every year.

Meteorological conditions also have an important share in determining the severity of the disease. On those tracts subject to inundations in spring a very hot, dry summer is apt to cause a severe outbreak. The relation which the bacillus bears to these conditions is not positively known. It may be that during and immediately after inundations or in stagnant water the bacilli find enough nourishment in the water here and there to multiply and produce an abundant crop of spores, which are subsequently carried, in a dry condition, by the winds during the period of drought and disseminated over the vegetation. Animals feeding upon this vegetation may contract the disease if the spores germinate in the body.

Another source of the virus, and one regarded by many authorities as perhaps the most important, is the body of an animal which has died of anthrax. It will be remembered that in such bodies the anthrax bacilli are present in enormous numbers, and wherever blood or other body fluids are exposed to the air on the surface of the carcass there the formation of spores will go on in the warm season of the year with great rapidity. It will thus be readily understood how this disease may become stationary in a given locality and appear year after year and even grow in severity if the carcasses of animals which have succumbed to it are not properly disposed of. These should be buried deeply, so that spore formation may be prevented and no animal have access to them. By exercising this precaution the disease will not be disseminated by flies and other insect pests.

We have thus two agents at work in maintaining the disease in any locality—the soil and meteorological conditions and the carcasses of animals that have died of the disease. Besides these dangers, which are of immediate consequence to cattle on pastures, the virus may be carried from place to place in hides, hair, wool, hoofs, and horns, and

it may be stored in the hay or other fodder from the infected fields and cause an outbreak among stabled animals feeding upon it in winter. In this manner the affection has been introduced into far-distant localities.

*How cattle are infected.*—We have seen above that the spores of the anthrax bacilli, which correspond in their functions to the seeds of higher plants and which are the elements that resist the unfavorable conditions in the soil, air, and water longest, are the chief agents of infection. They may be taken into the body with the food and produce disease which begins in the intestinal tract; or they may come in contact with scratches, bites, or other wounds of the skin, the mouth, and tongue, and produce in these situations swellings or carbuncles. From such swellings the bacilli penetrate into the blood and produce a general disease.

It has likewise been claimed that the disease may be transmitted by various kinds of insects which carry the bacilli from the sick and inoculate the healthy as they pierce the skin. When infection of the blood takes place from the intestines the carbuncles may be absent. It has already been stated that since the anthrax spores live for several years the disease may be contracted in winter from food gathered on permanently infected fields.

The disease may appear sporadically, i. e., only one or several animals may be infected while the rest of the herd remain well, or it may appear as an epizootic attacking a large number at about the same time.

*Symptoms.*—The symptoms in cattle vary considerably, according as the disease begins in the skin, in the lungs, or in the intestines. They depend also on the severity of the attack. Thus we may have what is called *anthrax peracutus*, or apoplectiform, when the animal dies very suddenly, as if from apoplexy. Such cases usually occur in the beginning of an outbreak. The animal, without having shown any signs of disease, suddenly drops down in the pasture and dies in convulsions, or an animal apparently well at night is found dead in the morning.

The second type (*anthrax acutus*), without any external swellings, is the one most commonly observed in cattle. The disease begins with a high fever. The temperature may reach 106° to 107° F. The pulse beats from 80 to 100 per minute. Feeding and rumination are suspended. Chills and muscular tremors may appear and the skin show uneven temperature. The ears and base of the horns are cold, the coat staring. The animals are dull and stupid and manifest great weakness.

To these symptoms others are added in the course of the disease. The dullness may give way to great uneasiness, champing of the jaws, spasms of the limbs, kicking and pawing the ground. The breathing

may become labored. The nostrils then dilate, the mouth is open, the head raised, and all muscles of the chest are strained during breathing, while the visible mucous membranes (nose, mouth, rectum, and vagina) become bluish. If the disease has started in the bowels, there is much pain, as shown by the moaning of the animal; the discharges, at first firm, become softer and covered with serum, mucus, and blood.

As the disease approaches the fatal termination the weakness of the animal increases. It leans against supports or lies down. Blood vessels may rupture and give rise to spots of blood on the various mucous membranes and bloody discharges from nose, mouth, rectum, and vagina. The urine not infrequently contains blood (red-water). Death ensues within one or two days.

A third type of the disease (*anthrax subacutus*) includes those cases in which the disease is more prolonged. It may last from three to seven days and terminate fatally or end in recovery. In this type, which is rarely observed, the symptoms are practically as described in the acute form, only less marked.

In connection with these types of intestinal anthrax, swellings may appear under the skin in different parts of the body, or the disease may start from such a swelling, caused by the inoculation of anthrax spores in one of the several different ways already described. If the disease begins in the skin it agrees in general with the subacute form in prolonged duration, and it may occasionally terminate in recovery if the swellings are thoroughly incised and treated.

*Lesions.*—These swellings appear as edemas and carbuncles. The former are doughy tumors of a more or less flattish form passing gradually into the surrounding healthy tissue. They are situated, as a rule, beneath the skin in the fatty layer, and the skin itself is at first of healthy appearance, so that they are often overlooked, especially when covered with a good coat of hair. When they are cut open they are found to consist of a peculiar jelly-like mass of a yellowish color and more or less stained by blood. The carbuncles are firm, hot, tender swellings, which later become cool and painless and undergo mortification. The edemas and carbuncles may also appear in the mouth, pharynx, larynx, in the tongue, and in the rectum.

The bodies of cattle which have died of anthrax soon lose their rigidity and become bloated, because decomposition sets in very rapidly. From the mouth, nose, and anus blood-stained fluid flows in small quantities. When such carcasses are opened and examined, it will be found that nearly all organs are sprinkled with spots of blood or extravasations of various sizes. The spleen is enlarged from two to five times, the pulp blackish and soft and occasionally disintegrated. The blood is of tarry consistency, not firmly coagulated, and blackish in color. In the abdomen, the thoracic cavity, and in the pericardium, or bag surrounding the heart, more or less blood-stained

fluid is present. In addition to these characteristic signs, the carbuncles and swellings under the skin, already described, will aid in determining the true nature of the disease. The most reliable method of diagnosis is the examination of the blood and tissues for anthrax bacilli. This requires a trained bacteriologist. The fatal cases of anthrax number from 70 to 90 per cent, and are usually more numerous at the first outbreak of the disease.

*Differential diagnosis.*—The diagnosis from blackleg may be made by noting the subcutaneous swellings which appear upon the patient. Those of blackleg are found to crackle under pressure with the finger, owing to the presence of gas within the tissues, while the tumors of anthrax, being due to the presence of serum, are entirely free from this quality and have a somewhat doughy consistence. The tumors of blackleg usually locate on the shoulder or thigh and are not found so frequently about the neck and side of the body as are the swellings of anthrax. The blood of animals dead of blackleg is normal, and the spleen does not appear swollen or darkened, as in animals affected with anthrax. The chief differences between anthrax and Texas fever are that the course of the former is more acute and the blood of the animal is dark and of a tar-like consistence, while in the case of Texas fever it will be found thinner than normal. The presence of Texas fever ticks on the cattle would also lead one to suspect Texas fever in regions where cattle are not immune from this disease.

*Treatment.*—This is as a rule ineffectual and useless, excepting perhaps in cases which originate from external wounds. The swellings should be opened freely by long incisions with a sharp knife and washed several times daily with carbolic acid solution (1 ounce to a quart of water). Care should be taken to disinfect thoroughly any fluid discharge that may follow such incision. When suppuration has set in, the treatment recommended in the chapter on wounds should be carried out.

*Prevention.*—Since treatment is of little or no avail in this disease, prevention is the most important subject demanding consideration. The various means to be suggested may be brought under two heads: (1) The surroundings of the animal, and (2) protective inoculation.

(1) What has already been stated in the foregoing pages on those conditions of the pastures which are favorable to anthrax will suggest to most minds, after a little thought, some of the preventive measures which may be of service in reducing losses in anthrax localities. All that conduces to a better state of the soil should be attempted. The State or nation should do its share in preventing frequent inundations, by appropriate engineering. If pools of stagnant water exist on the pastures, or if any particular portions are known by experience to give rise to anthrax, they should be fenced off. Efforts should likewise be made toward the proper draining of swampy lands fre-

quented by cattle. Sometimes it has been found desirable to abandon for a season any infected and dangerous pastures. This remedy can not be carried out by most farmers, and it is liable to extend the infected territory. In some instances withdrawal of cattle from pastures entirely and feeding them in stables is said to have reduced the losses.

It is of the utmost importance that carcasses of animals which have died of anthrax should be properly disposed of, since every portion of such animal contains the bacilli, ready to form spores when exposed to the air. Perhaps the simplest means is to bury the carcasses deep, where they can not be exposed by dogs or wild animals. It may be necessary to bury them on the pasture, but it is better to remove them to places not frequented by susceptible animals and to a point where drainage from the graves can not infect any water supply.

If they are moved some distance it must be borne in mind that the ground and all objects which have come in contact with the carcass should be disinfected. This is best accomplished with chloride of lime. For washing utensils, etc., a 5 per cent solution may be prepared by adding 3 ounces to 2 quarts of water. This should be prepared fresh from the powder, and it is but little trouble to have a small tin measure of known capacity to dip out the powder, to be added to the water whenever necessary. The carcass and the ground should be sprinkled with powdered chloride, or, if this be not at hand, an abundance of ordinary unslaked lime should be used in its place.

The removal of carcasses to rendering establishments is always fraught with danger, unless those who handle them are thoroughly aware of the danger of scattering the virus by careless handling in wagons which are not tight. As a rule, the persons in charge of such transfer have no training for this important work, so that deep burial is to be preferred. Burning large carcasses is not always feasible. It is, however, the most certain means of destroying infectious material of any kind, and should be resorted to whenever practicable and economical. All carcasses, whether buried, rendered, or burned, should be disposed of without being opened. When stables have become infected they should be thoroughly cleaned out, and the solution of chloride of lime freely applied on floors and woodwork. The feed should be carefully protected from contamination with the manure or other discharges from the sick.

(2) *Preventive inoculation.*—One of the most important discoveries in connection with this disease was made by Louis Pasteur in 1881, and consisted in the new principle of producing immunity by the inoculation of weakened cultures of the bacillus causing the disease. This method has been quite extensively adopted in France, and to some extent in other European countries, and in the United States. The fluid used for inoculation consists of bouillon in which modified

anthrax bacilli have multiplied and are present in large numbers. The bacilli have been modified by heat so that they have lost to a certain degree their original virulence. Two vaccines are prepared. The first or weaker for the first inoculation is obtained by subjecting the bacilli to the attenuating effects of heat for a longer period of time than is the case with the second or stronger vaccine for a second inoculation some twelve days later.

These vaccines have been used for cattle and sheep. Their power to prevent a subsequent attack of anthrax has been the subject of controversy ever since their use began. The French claim that the vaccines are successful in protecting cattle and sheep and that the losses from anthrax in France have been much reduced by their persistent application. According to other observers there are several difficulties inherent in the practical application of anthrax vaccination. Among these may be mentioned the variable degree of attenuation of different tubes of the vaccine and the varying susceptibility of the animals to be inoculated. Nevertheless, the use of this vaccine is increasing and has reduced the mortality in the affected districts from an average of 10 per cent with sheep to less than 1 per cent, and from 5 per cent with cattle to less than one-half of 1 per cent.

It is very important to call attention to the possibility of distributing anthrax by this method of protective inoculation, since the bacilli themselves are present in the culture liquid. It is true that they have been modified and weakened by the process adopted by Pasteur, but it is not impossible that such modified virus may regain its original virulence after it has been scattered broadcast by the inoculation of large herds. No vaccination should, therefore, be permitted in localities free from anthrax. It is also obviously unsafe to have such vaccine injected by a layman; instead, it should be handled only by a competent veterinarian.

Anthrax is an entirely different disease from blackleg, and therefore blackleg vaccine does not act as a preventive against anthrax.

#### ANTHRAX IN HORSES.<sup>a</sup>

Infection of an animal takes place through inoculation or contact of the bacillus or its spores with an abraded surface or mucous membrane on a sound animal. In an infected district horses may eat the rich pasturage of spring and early summer with impunity, but when grass becomes low they crop it close to the ground, pull up the roots around which the virus may be lodged, and under these conditions

<sup>a</sup> The paragraphs on anthrax in horses are by Dr. Rush Shippen Huidekoper, published in Special Report on Diseases of the Horse. Revised in 1904 by Leonard Pearson, B. S. V., M. D.



the animals are more apt to have abrasions of the lips or tongue by contact with dried stubble and the dirt on the roots, which favors the introduction of the germs into the system. The virus may be introduced with food and enter the blood-vessel system from the stomach and intestines. If contained in the dust, dried hay, or on the parched pasture of late summer, the virus may be inhaled and be absorbed from the lining of the lungs. If contained in harness leather, it needs but an abrasion of the skin, as the harness rubs it, to transfer the spore from the leather to the circulation of the animal.

The writer saw a case of anthrax occur in a groom from the use of a new horse brush. The strap which passes over the back of the hand inoculated an abrasion on the knuckle of the first finger, and in twelve hours a "pustule" had formed and the arm had become infected.

*Symptoms.*—The symptoms of anthrax usually develop with extreme rapidity. The horse is dejected and falls into a state of profound stupor, attended by great muscular weakness. The feeble, indolent animal, if forced to move, drags its legs. There are severe chills, agitation of the muscles, symptoms of vertigo, and at times colicky pains. The mucous membranes turn a deep ocher or bluish-red color. The body temperature is rapidly elevated to 104° or 105° F. The breathing is increased to 30 or 40 respirations in the minute, and the pulse is greatly accelerated, but while the arteries are soft and almost imperceptible, the heart beats can be felt and heard, violent and tumultuous. In some cases, when inoculation is through the skin, large subcutaneous swellings appear; these may involve a leg, a shoulder, one side of the body, or the neck or head. The swelling is at first hot and painful, but afterwards it becomes necrotic and sensation is lost. The symptoms last but two, three, or four days at most, when the case usually terminates fatally. An examination of the blood shows a dark fluid which will not clot, and which remains black after exposure to the air. After death the bodies putrify rapidly and bloat up; the tissues are filled with gases, and a bloody foam exudes from the mouth, nostrils, and anus, and frequently the mucous membranes of the rectum protrude from the latter. The hairs detach from the skin. Congestion of all the organs and tissues is found, with interstitial hemorrhages. The muscles are friable and are covered with ecchymotic spots. This is specially marked in the heart.

The black, uncoagulated, and incoagulable blood shows an iridescent scum on its surface, which is due to the fat of the animal dissolved by the ammonia produced by the decomposed tissues. The serum oozes out of every tissue and contains broken-down blood, which, when examined microscopically, is found to have the red globules crenated and the leucocytes granular. A high power of the microscope also reveals the bacteria in the shape of little rod-like bodies of homogeneous texture with their brilliant spores. The

lymphatic ganglia are increased four, five, six, or ten times their natural size, enlarged by the engorgement of blood. The spleen shows nodulated black spots containing a muddy blood, which is found teeming with the virus. This organ is much enlarged and is quite friable. The mucous membranes of the intestines are congested and reddish brown; the surface of the intestines is in many places denuded of its lining membrane, showing fissures and hemorrhagic spots. The liver has a cooked appearance; the kidneys are congested and friable; the urine is red; the pleura, lungs, and the meninges are congested, and the bronchi of the lungs contain a bloody foam.

*Treatment.*—The treatment of anthrax has little in it to encourage one. The curative treatment, for which almost every drug in the pharmacopœia has been used, is practically without avail.

The prophylactic treatment formerly consisted in the avoidance of certain fields and marshes which were recognized as contaminated during the months of August and September and had been occupied the years in which the outbreaks usually occurred. It underwent, however, a revolution after the discovery by Pasteur of the possibility of a prophylactic inoculation or vaccination, which granted immunity from future attacks of the disease similar to that granted by the recovery of an animal from an ordinary attack of the disease.

This treatment consists in the use of a vaccine which is made by the artificial cultivation of the virus of anthrax in broth and in the treatment of it by means of continued exposure to a high temperature for a certain length of time, which weakens the virus to such an extent that it is only capable of producing a very mild and not dangerous attack of anthrax in the animal in which it is inoculated, and thus protects the animal from inoculation of a stronger virus. The production of this virus, which is carried on in some countries at the expense of the government and is furnished at a small cost to the farmers in regions where the disease prevails, in this country is made in private laboratories only.

#### ANTHRAX IN MAN (MALIGNANT PUSTULE, OR CARBUNCLE).

Anthrax may be transmitted to man in handling the carcasses and hides of animals which have succumbed to the disease. The infection usually takes place through some abrasion or slight wound of the skin into which the anthrax spores, or bacilli, find their way. The point of inoculation appears at first as a dark point or patch, compared by some writers to the sting of a flea. After a few hours this is changed into a reddened pimple, which bears on its summit, usually around a hair, a yellowish blister, or vesicle, which later on becomes red or bluish in color. The burning sensation in this stage is very great. Later on this pimple enlarges, its center becomes dry, gangrenous,

and is surrounded by an elevated discolored swelling. The center becomes drier and more leather-like and sinks in as the whole increases in size. The skin around this swelling, or carbuncle, is stained yellow or bluish and is not infrequently swollen and doughy to the touch. The carbuncle itself rarely grows larger than a pea or a small nut and is but slightly painful.

Anthrax swellings, or edemas, already described as occurring in cattle, may also be found in man, and they are at times so extensive as to produce distortion in the appearance of the part of the body on which they are located. The color of the skin over these swellings varies according to the situation and thickness of the skin and the stage of the disease, and may be white, red, bluish, or blackish.

As these carbuncles and swellings may lead, sooner or later, to an infection of the entire body, and thus be fatal, surgical assistance should at once be called if there is well-grounded suspicion that any swellings resembling those described above have been due to inoculation with anthrax virus. Inasmuch as physicians differ as to treatment of such accidents in man, it would be out of place to make any suggestions in this connection.

To show that the transmission of anthrax to man is not so very uncommon, we take the following figures from the report of the German Government for 1890: One hundred and eleven cases were brought to the notice of the authorities, of which 11 terminated fatally. The largest number of inoculations were due to the slaughtering, opening, and skinning of animals affected with anthrax. Hence the butchers suffered most extensively. Of the 111 thus affected, 36 belonged to this craft.

In addition to anthrax of the skin (known as malignant pustule), human beings are subject, though very rarely, to the disease of the lungs and the digestive organs. In the former case the spores are inhaled by workmen in establishments in which wool, hides, and rags are worked over, and it is therefore known as wool-sorter's disease. In the latter case the disease is contracted by eating the flesh of diseased animals which has not been thoroughly cooked. These forms of the disease are more fatal than those in which the disease starts from the skin.